Connecting the Numbers in the Primary Grades Using an Interactive Tool

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describe how a free Web-based tool can be used to enhance students' number sense across the primary school grades.

Introduction

Children are often intrigued by number patterns and games and so it makes sense for teachers to include them in their mathematics lessons. Puzzles encourage the use of critical thinking skills and provide practice in important skills areas. The use of games fosters mathematical learning and encourages the mathematical processes that children use (Su & Su, 2004). The Square Tool was created to promote students' interest in mathematics and has the potential to greatly assist our young students in better understanding mathematics and number sense concepts.

The Square Tool

The Square Tool is an emerging technology created using Java, a programming language. The tool is free to access for classroom or home use and can be found at http://mcs-research.barry.edu/squares/ (Su, Marinas & Chraibi, 2008). Its window allows the user to select any square array of numbers up to 20 × 20. Figure 1 shows a 5 × 5 square and Figure 2 shows the simple interface.

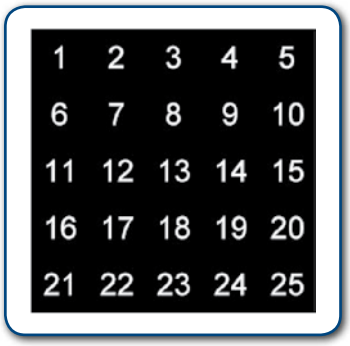

Figure 1. The Square Tool.

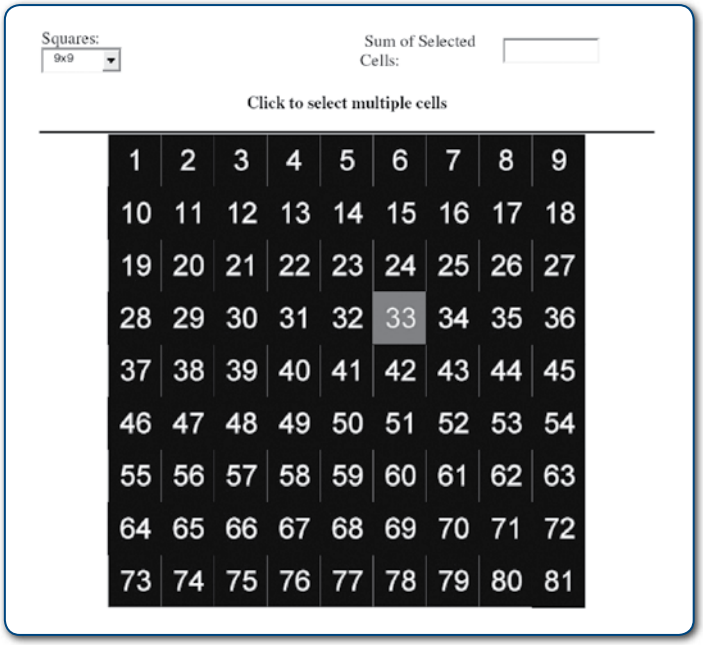

Figure 2. Square tool web-interface.

A user can click on any numbers within the 5 × 5 square (or any other) and the sum of the selected cells is displayed instantly. This allows for many number connections, enabling teachers of any grade level to use the tool with their students to help explore different number relationships. Like other Web-based mathematics software such as *Geogebra* or the *Library of Virtual Mathematics Manipulatives*, students find the Square Tool intriguing and like to explore various relationships that can be discovered using the software. This is useful, because according to the National Council of Teachers of Mathematics (NCTM, 2006), "through identifying, describing, and applying number patterns and properties in developing strategies for basic facts, children learn about other properties of numbers and operations, such as odd and even" (p. 19).

The Square Tool is easy to operate in that all students need to do is click on the numbers and the Square Tool adds the total, serving as a kind of calculator. It also allows young learners to explore numeric relationships dealing with multiples, primes, and many other number ideas. The next section provides more detailed descriptions of how the Square Tool can be used to develop an understanding of addition, multiplication, division and the properties of numbers.

Exploring number relationships

Addition

Students can use the Square Tool to explore adding any two even numbers or two odd numbers, and discover that the result is an even number. The tool facilitates the process quickly.

Multiplication

Using the tool for multiplication will help students develop the abstract concept of multiplication, as repeated addition. For example, multiplying 9 by 2 will require students to select the 9 × 9 grid. Each row represents a group of 9 items (see Figure 3). We want 2 groups (rows), so the answer is the last number in row 2 (i.e., 18).

Division

The tool will allow the user to explore the relationships between division and multiplication, since division is the inverse of multiplication. This activity can also help students build algebra concepts.

For example, to calculate 33 ÷ 9.

1. Choose 9 × 9 from the drop down Size menu.
2. Click on the Create Grid button.
3. Select 33 in the grid. By counting the complete rows of 9 before 33 it can easily be seen that 33 divided by 9 is 3 and that there is a remainder of 6 (3 complete rows and 6 additional numbers in the fourth row).

We can write this as $33 = 9 \times 3 + 6$. or as $33 = 9 \times \square + \square$ which leads into algebra.

The Square Tool can also be used to illustrate that 33 can also be expressed as:

- 2 rows of 9 and 15 remaining. So $33 = 9 \times 2 + 15$.
- 1 row of 9 and 24 remaining blocks. So $33 = 9 \times 1 + 24$.

and so on.

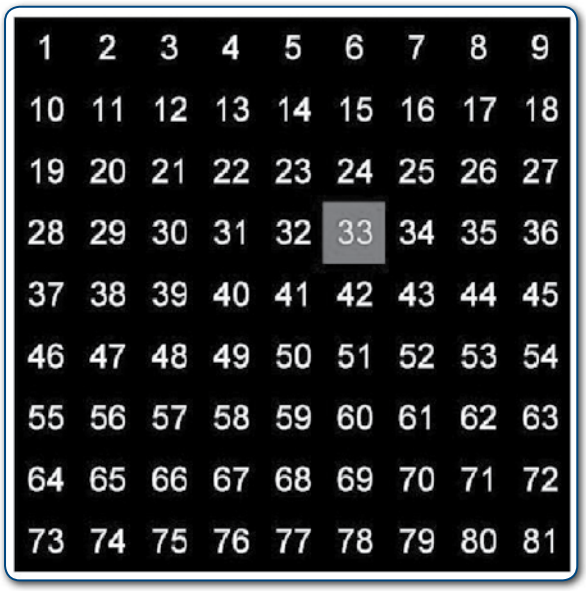

Figure 3. 33 in the 9 ⊆ 9 square.

Exploring number properties

The Square Tool is useful in the upper primary grades for teaching topics in number theory. Number theory includes the study of number properties, prime and composite numbers, the Sieve of Eratosthenes, multiples, factors, and modular arithmetic. Throughout the history of mathematics, mathematicians such as Euler, Gauss, Fermat, Euclid, and Pythagoras have been fascinated by number patterns of primes, factors, and amicable numbers, and have made important contributions to number theory.

Eratosthenes created an organised system to help identify prime numbers. He called his system the Sieve of Eratosthenes. The Square Tool can be used as a Sieve of Eratosthenes to help find prime numbers. The following steps will take you through finding primes less than 100.

1. Go to: http://mcs-research.barry.edu/squares/. Select the 10 × 10 grid.
2. The number 1 is not classed as a prime number, so the smallest prime number is 2. Highlight all the multiples of two, excluding 2 (4, 6, 8, 10, 12, 14, 16, 18, etc.).
3. The next non-highlighted number is a prime number (3). Highlight all multiples of 3, excluding the number 3. Some of the numbers are already highlighted because they are also multiples of 2. (6, 9, 12, 15, 18, 21, 24, 27, 30, 33, 36, 39, 42, 45, 48, 51, 54, 57, 60, 63, 66, 69, 72, 75, 78, 81, 84, 87, 90, 93, 96, 99).
4. Highlight all the multiples of next prime (5) up to 100 excluding the number 5. (10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100). Some of the numbers are already highlighted as they are also multiples of 2 and/or 3.
5. Highlight all the multiples of next prime (7) up to 100 excluding the number 7. Since most of the numbers are already highlighted as they are also multiples 2, 3, and 5 the only remaining multiples of 7 are 49, 77, and 91.
6. All the remaining numbers on the grid are prime as shown in black in Figure 4.

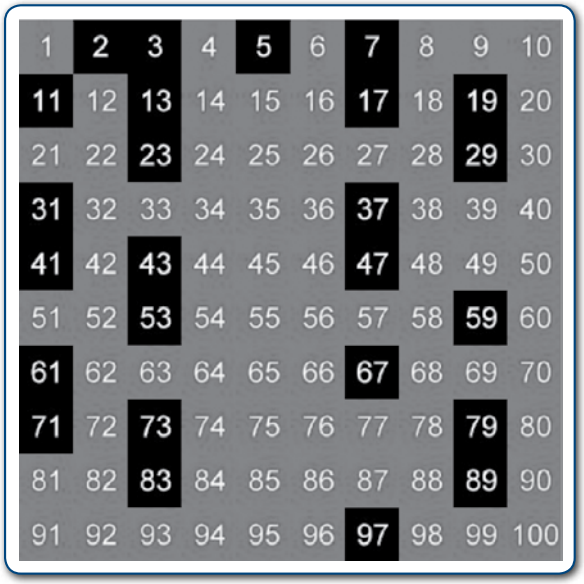

Figure 4. Prime numbers.

Numerous tools are available on the Internet to help students make numeric connections such as identifying prime and composite numbers. In addition to previously mentioned advantages, the Square Tool will help reinforce the concepts of primes, composites, and multiples. For example, the teacher can make copies of the 10 × 10 grid and allow the students to find multiples by using different colors.

The Square Tool can be used for factor identification such as greatest common factor (GCF) and factors. The GCF is the largest number that divides two numbers. For example the GCF for 12 and 16 is 4, as 4 is the largest number both 12 and 16 can be divided by evenly without a remainder. Factors are factors of n other than itself. The proper factors of 12 are {1, 2, 3, 4, 6}.

Summary

Although there are numerous computational tools on the Internet today, the Square Tool offers users the opportunities to examine number connections such as addition, subtraction, multiplication, and division. In addition to the basic operations, the tool offers users the opportunities to explore more abstract ideas, including identifying primes, composites, and multiple numbers. As Ozel, Yetkiner, and Capraro (2008) have found in their research that using technology in the mathematics classroom supports different teaching and learning strategies and objectives. Today's students must be able to represent and analyse patterns and functions, using words, tables, and graphs (NCTM, 2006). The Square Tool can help students discover many number relationships and it is hoped that teachers from around the world will utilise the site with their students and find it a valuable resource.

Acknowledgement

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